

ORACLES P3 Flight Scientist Report

Date: 19 October 2018

Flight number: PRF11Y18

Routine flight or target of opportunity? Opp.

If target of opportunity, what is the goal? Resample fresh aerosol plume in Bight of Angola

Flight scientist: Samuel LeBlanc

Assistant flight scientist: n/a

Ground scientist: Sarah Doherty

Asst. Ground scientist: _____

Take-off: 06:53:03UT (from TMS)

Landing: 14:40:07UT (at TMS)

Quick summary:

Representative ACAOD or ACAOD range for flight: 0.2 - 0.27

Do the models predict crossing a gradient in aerosol age? Yes/No/Unclear

Notes: Sampling Fresh plume, near coast, similarly to previous flight

Did the flight cross a gradient in macroscopic cloud properties, like cloud fraction? Yes/No/Unclear

Notes: Flew same area, clear first, then advection of clouds (near overcast) 2h later.

Did the flight cross a gradient in aerosol loading? Yes/No/Unclear

Notes: Models predicted increased loading in thin strip at around 10S going NW – SE.

Measured, but to a lesser degree.

At any point during the flight, was there a clear separation between the smoke plume(s) and cloud tops? Yes/No/Unclear

Notes: Consistently in sampling area, expected 'bacon' layer directly above cloud was absent.

How many of the following maneuvers took place?

Ramps 2

Square spirals 2

MBL legs 3

Cloud legs 2

Above cloud legs 4

Sawtooth legs 2

Plume legs 5

Above plume legs 4

Instrument status:

Instrument	Comments
P3	--
4STAR	Good day, everything working fine, window mostly clean, highest AOD 0.35, 0.28 ACAOD, 45 minutes after
HiGEAR	Excellent day, everything worked. Tried both new sampling modes. Unexciting because of no huge plume, but the cloud leg was great (Oh my!). Actually, seeing 30nm particles forming cloud droplets. Clouds much more heterogeneous than expected. Implies super sat at .5%.
HiGEAR-AMS	Had a good day, a bit bummed by the low aerosol concentration.
PTI/SP2	Good day, but boring compared to other flight. Good to see mixing state from CVI.
HSRL-2	Worked well. Happy with data obtained. Some troubles locking the seed laser (355nm, unaffected today but had to try harder to get to lock), will need to swap out on next down day.
RSP	Good day, clear skies, cloudy skies, aerosol, everything you can want.
APR3	Worked fine. Not much to see in first half, after spiral, saw clouds at 3kft, and saw some stuff in W band. Way back saw drizzle and all 3 freq responding
Cloud probes	Everything worked well. Got a nice nap. Both dull and sharp sawtooths worked well. No CAPS
CCN	CCN ran well. Good contrast to last flight. Filter was good.
PDI	--
Vertical Winds	Looks good
WISPR/CVI	Everything worked fine. Cool dataset. Obvious evidence of past precip both in boundary layer and at top of the aerosol plumes.
COMA	Had a good flight. Everything worked. CO a bit above 200ppb New dark chocolate (nestle) which was good.
SSFR	We had a really good day. Everything worked - clear sky spiral+rad wall. Data under broken cloud really useful.
data	Worked well. Aux cable is breaking.

Flight Scientist: Samuel LeBlanc

Ground Scientist: Sarah Doherty

Flight plan and objective:

- Flight of opportunity to the Blight of Angola, near fresh plume sources. Try to resample the 'bacon' layer of fresh aerosol, and location of sampling from 2016
- Focus on in situ sampling, and clear to cloudy air transitions under aerosol plume
- Verify model prediction of thin aerosol plume.
- Transit down via 7°E and focus on area near 10°E / 10°S

Flight Summary:

Focus on the eastern location where there is predicted a fresher aerosol plume. Moved north-south sampling further north and west to avoid high cirrus, and center on clear skies to cloudy skies transition. ACAOD measured ~0.27, evidence of very clean air directly above clouds, and obvious lack of 'bacon' layer sampled previously in the region. Some highlights of the flight include:

- Tried to sample fresh plume again Eastward near Blight of Angola, but not found (low aerosol concentration as opposed to previous flight)
- ACAOD ~0.27, and full column AOD ~0.35
- 2 square spirals near each other, one over clear skies, the other over partially cloudy. The bottom of one square spiral had **a ship and its plume**.
- Clean MBL, and **ultra-clean above clouds**
- Underfly of partial cloudy skies – high potential of 3D cloud-aerosol radiative effect.
- Lots of good in situ sampling, while in cloud. (TDMA+CVI) – showing indication of large aerosols.
- Resample of same location with HSRL about 2 hours apart, with some focus on a potential thin dust plume (high depolarization ration indicating dust)
- High number of cloud drop concentration near bottom of clouds (opposite of what has been observed in the past).

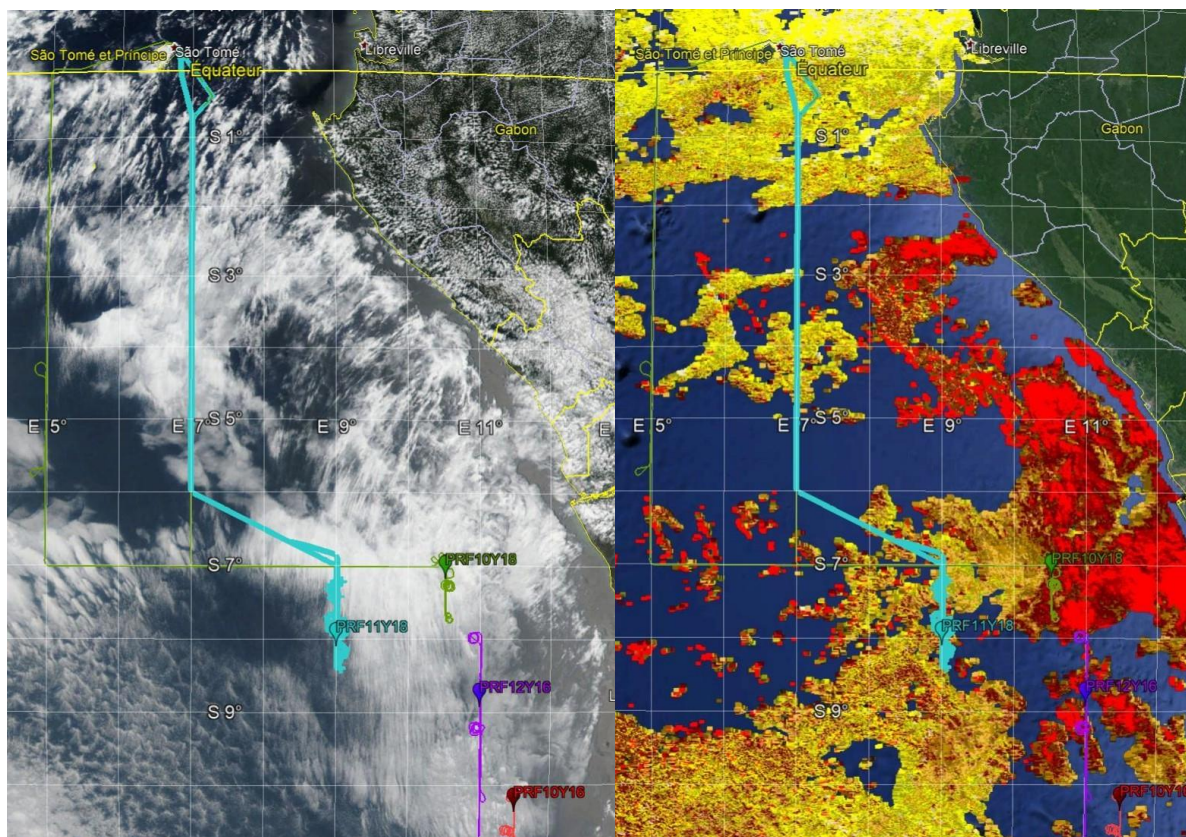


Figure 1 – PRF11Y18 Flight track (cyan) on: (right) NPP-VIIRS (13:30UTC) imagery, previous flight track (PRF10Y18, PRF12Y16, PRF10Y16) in other colors. (left) MODIS ACAERO above cloud AOD.

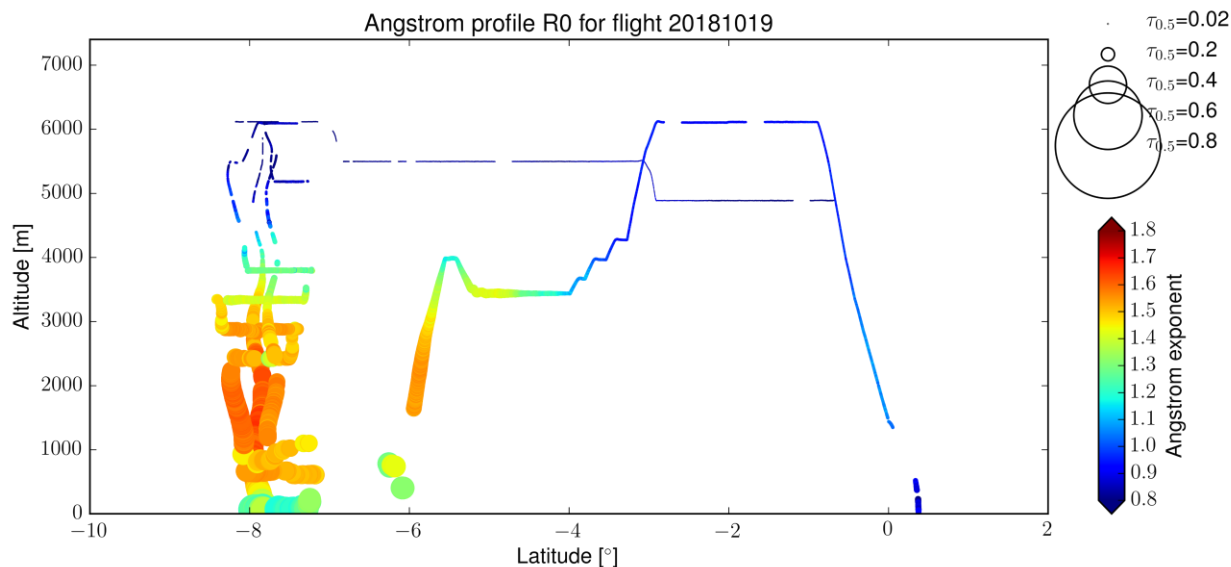


Figure 2 – Flight path profile as a function of Latitude, color-coded by angstrom exponent, with size denoting the measured AOD. Square spirals at 8°S, with boundary layer sampling nearby.

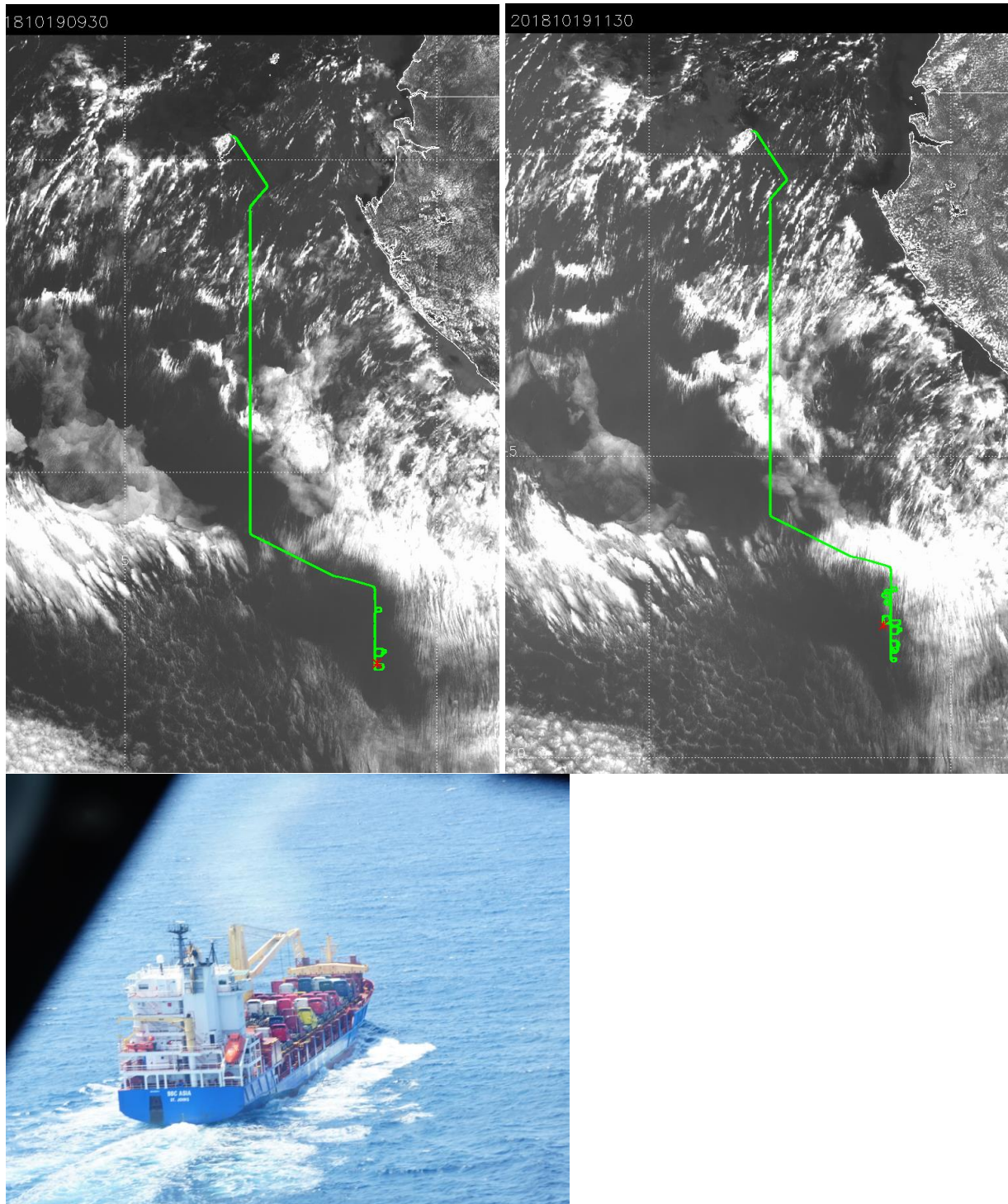


Figure 3 – flight path on SEVIRI visible imagery at (right) 9:30 UTC and (left) 11:30, showing the advection of clouds onto sampling area. (bottom) photo of ship at the bottom of the first square spiral on the southern edge of pattern.

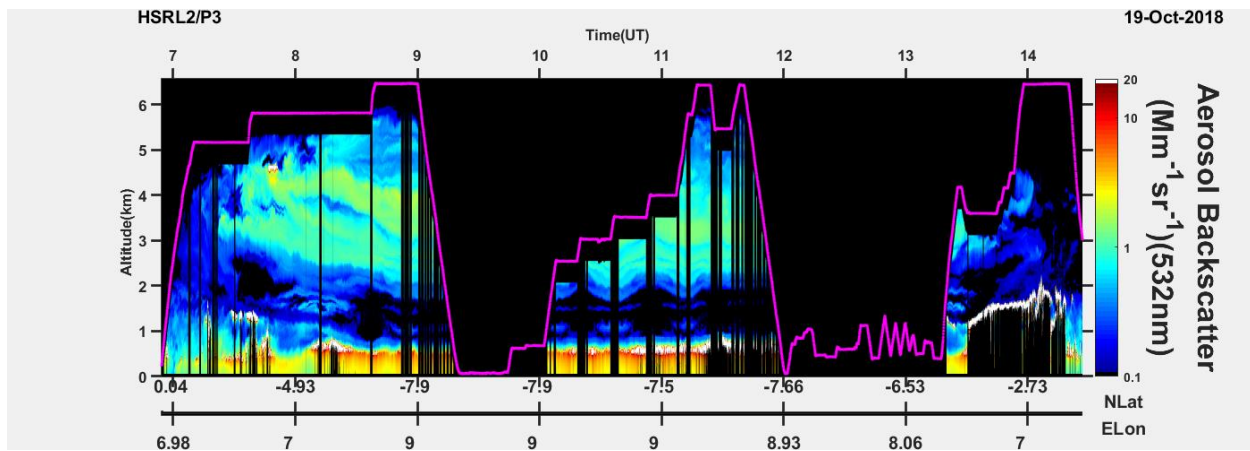


Figure 4 – Aerosol backscatter (532 nm) from HSRL-2 for entire flight, with distinct absence of aerosol above clouds during transit and near sampling region.

A-Priori Forecast and forecast evaluation:

Expectation of comparatively very young aerosol plume near shore of Angola. Thin sinuous aerosol layer is predicted flowing diagonal south-east to north-west. Clearing of low clouds expected in region near-coast (10°E – 10°S), but nearby high-cirrus clouds may be prevalent. The thin aerosol layer was not sampled – likely more south than forecast. Significant clearing of aerosol layer directly above clouds. Cloud forecast similar to reality with evidence of clearing and advection.

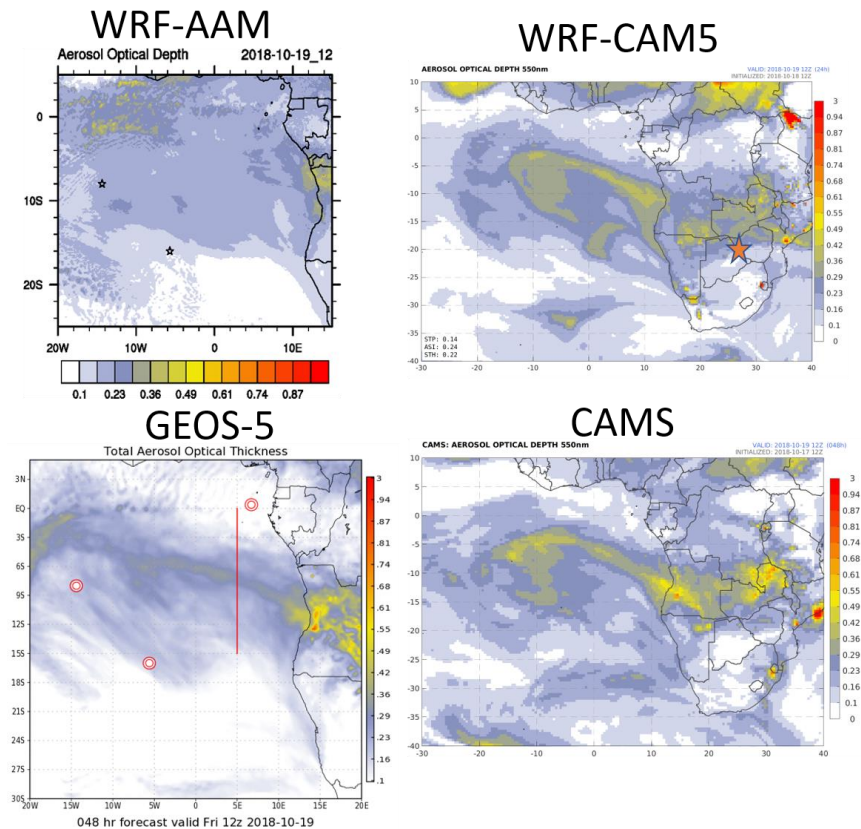


Figure 5 – Aerosol optical thickness forecast from 4 aerosol models. WRF-AAM is not predicting this thin aerosol diagonal layer.

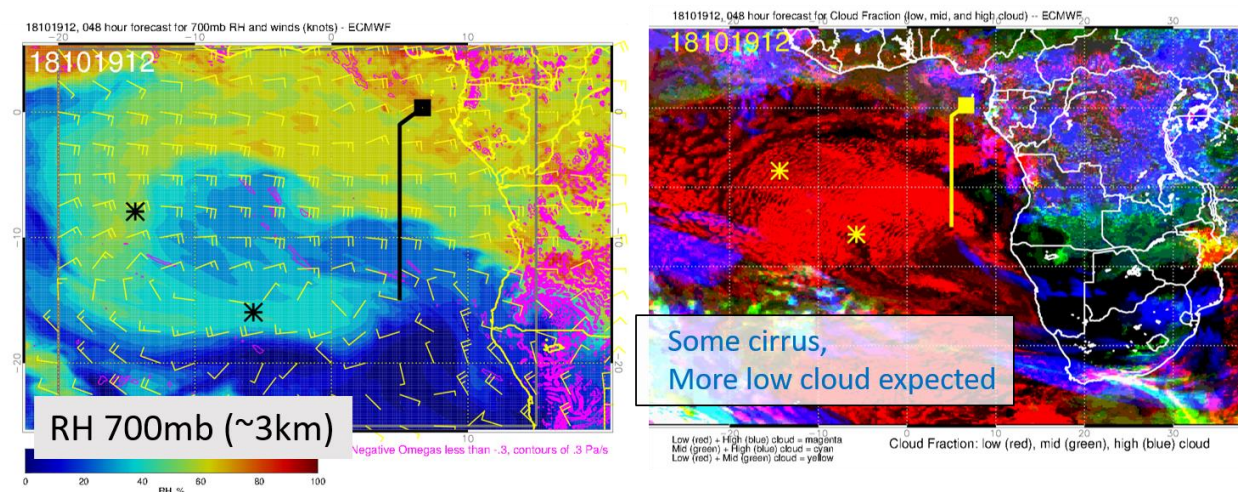


Figure 6 – Forecast meteorological fields of relative humidity at 700 mb with wind barbs and expected cloud scene, with low cloud clearing.

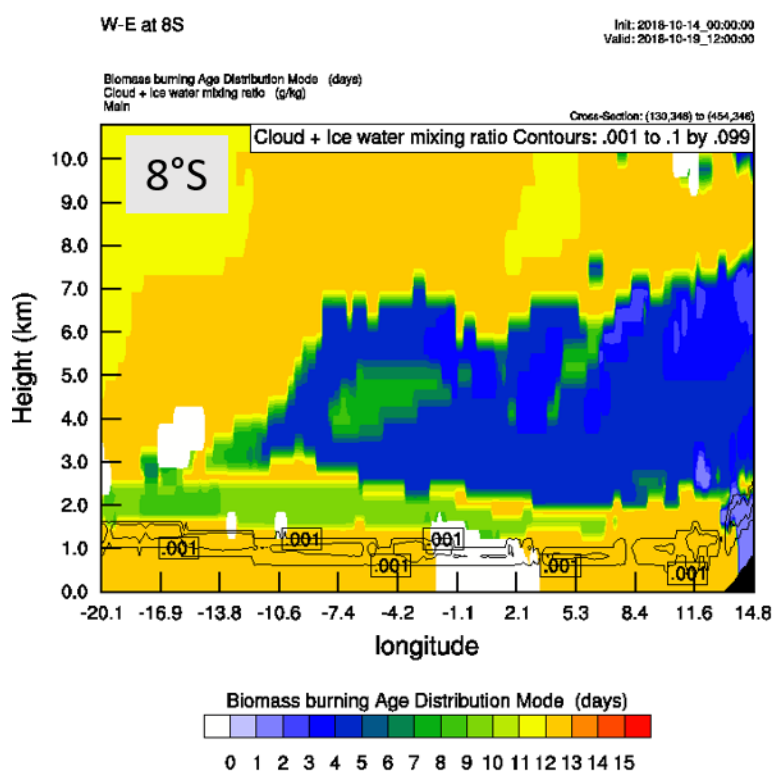
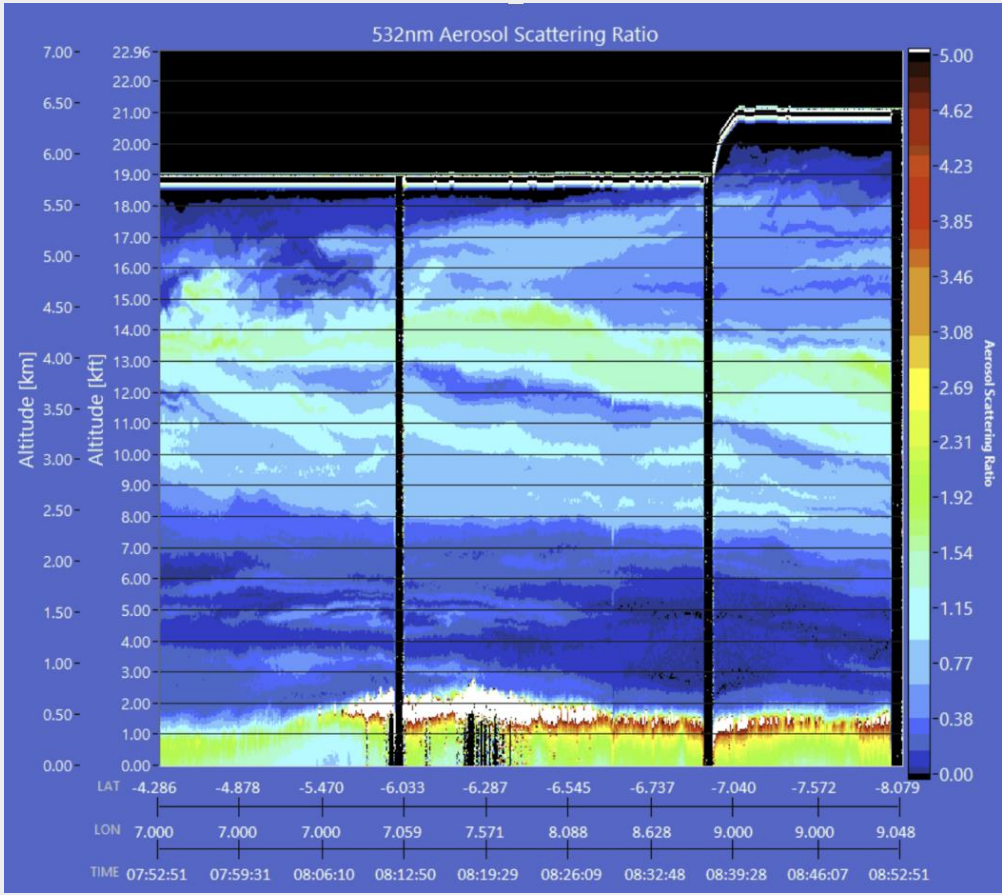



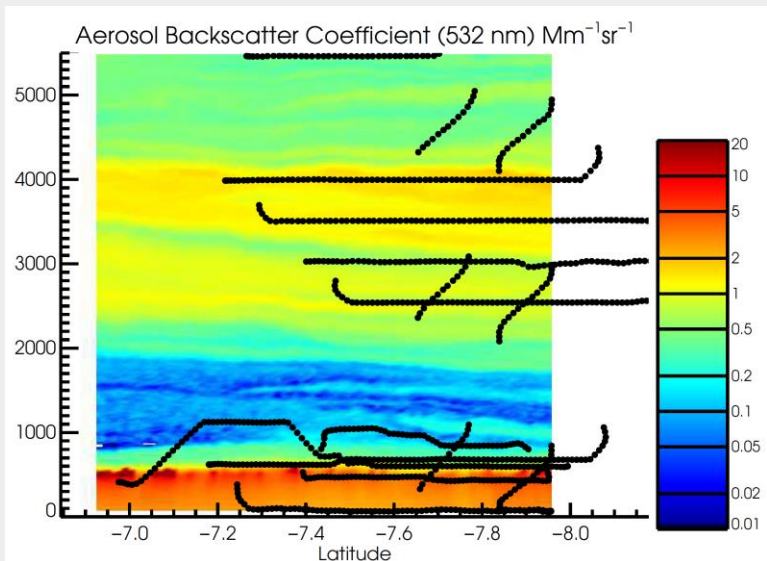
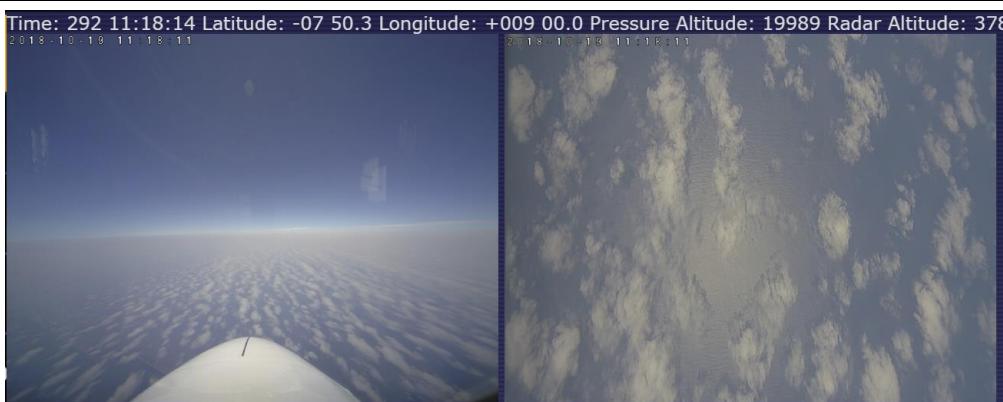
Figure 7 – Biomass burning age distribution from WRF-AAM, with clear young aerosol directly above cloud at 8°S and 10°E


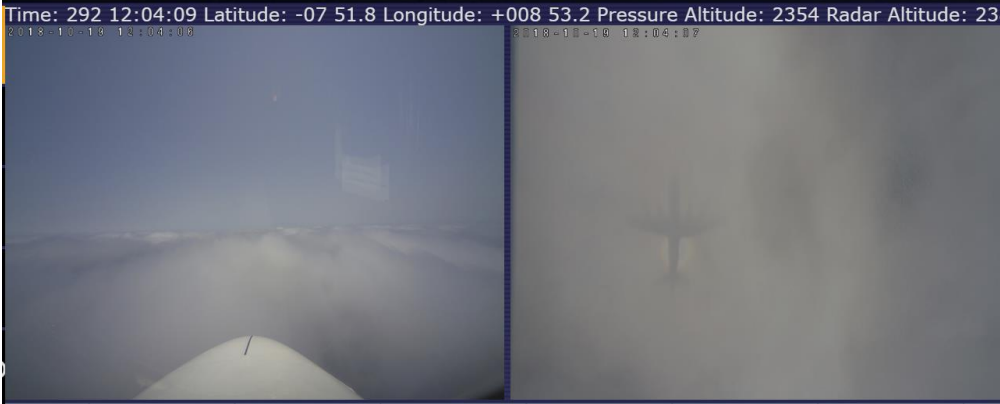
Flight Instrument status: All instruments were performing well, besides small non-impacting issues. CAPS still not working.

Run Table [UTC; approximate times okay, lack of detail okay]


description	beginning time	end time	altitude	notes
takeoff	6:53:03	X	0-18 kft	Very low cloudiness, and mostly very clean on ascent, some evidence of aerosol layer at 9kft with elevated CO (120-130 ppb), with variations in CN and scattering.
Ferry leg	7:05	8:51	16 – 21 kft	Few midlevel clouds (near 4°S), clear to ocean, low clouds starting at 6.5°S, thin elevated (9-11 kft) aerosol layer starting at 1.6°S
	 <p>The figure is a 532nm Aerosol Scattering Ratio plot. The y-axis represents altitude in both kilometers (0.00 to 7.00) and kilofeet (0.00 to 22.96). The x-axis represents time from 07:52:51 to 08:52:51, with latitude (LAT) and longitude (LON) coordinates marked at the bottom. A color scale on the right indicates the aerosol scattering ratio from 0.00 (dark blue) to 5.00 (dark red). The plot shows a clear aerosol layer near the surface (below 2 km) and some mid-level scattering between 4 and 6 km. Two vertical black lines are drawn at approximately 08:12:50 and 08:39:28, corresponding to the 'Backtrack over square spiral point' event.</p>			
Backtrack over square spiral point	8:51	9:00	21 kft	Severe clear above and below, aerosol layer below is not very thick

description	beginning time	end time	altitude	notes
Square spiral	9:00	9:20	21 – 0.2 kft	Mostly severe clear, some thin low level clouds above once near surface. Clearing of aerosol at 4 kft, no distinct peak.
Low level leg and ship plume	9:20	9:42	0.2 kft	Ship appeared nearly directly below square spiral, intercept of ship plume (relatively low aerosol CN, BC at 250 ng/m ³) at 9:30, chase after ship afterwards. Mostly clean boundary layer, aod ~0.35
				
Climb to above cloud	9:42	9:46	0.2 - 3 kft	Cloud layer tenuous, mostly wisps and missed during ascent.
Above cloud	9:46	10:02	~3 kft	Clean, ACAOD ~0.28, clouds tops increasing in altitude with time.
In plume stacked legs	10:02	11:10	8, 9.4, 11, 12.5 kft	8kft, 9.4 kft, 11 kft, 12.5 kft, with peak aerosol loading at 9.4 kft, Clear below, with clouds advecting in.

description	beginning time	end time	altitude	notes
				
High alti leg, above plume	11:10	11:40	16 – 20 kft	Resampling of highest tenuous aerosol layer seen in HSRL, barely observed with in stu, disappearance of highest aerosol layer. Building of low level altocumulus clouds below.
				
Square spiral (2 nd)	11:40	12:01	21 – 0.2 kft	Near location of 1 st square spiral, now with cloudy, Not much evolution in aerosol layer, clean below 3kft. Peak aerosol layer at ~11 kft (range of 7 -14 kft). Thin Cloud at 1 kft

description	beginning time	end time	altitude	notes
				
Above then below clouds	12:04	12:26	1.4 – 3.6 kft	Cloud tops increasing in altitude, with distinct cells bubbling up. Gradient in ACAOD 0.27 – 0.23. Very clean MBL and directly above cloud.
	<div> <div>Time: 292 12:04:09 Latitude: -07 51.8 Longitude: +008 53.2 Pressure Altitude: 2354 Radar Altitude: 23</div>  </div>			
In cloud	12:26	12:34	1.9 kft	Intermittent clouds. Cloud Nd peak at 200/cc. Low LWC (<0.5g/m ³). Evidence of large CN within clouds, when sampling behind CVI.
Cloud dull sawtooth	12:34	13:17	1.3 – 4.2 kft	High drop number concentration at the lowest part of the cloud. (dull sawtooth, then sharp sawtooth, then dull). Ran out of clouds near the end. Full column AOD at the last bottom of cloud was 0.3.

description	beginning time	end time	altitude	notes
	<p>The figure consists of two vertically stacked plots sharing a common x-axis labeled 'Seconds Since Midnight 10-19-2018' ranging from 44800 to 47000. The top plot has two y-axes: the left axis is 'LWC (g/m³)' from 0.0 to 3.0, and the right axis is 'Total Number Concentration (#/cc)' from 0 to 300. It shows a blue line for LWC and a red line for Total Number Concentration. The bottom plot has a y-axis for 'Drop Diameter (μm)' on a log scale from 0.1 to 100, and a color bar for 'Concentration (dN/dlogDp)' from 0 to 2000. A black line represents 'GPS Altitude (m)' on the right y-axis, ranging from 0 to 5000. The bottom plot shows a dense field of colored dots representing aerosol concentration as a function of drop size and time.</p>			
Climb out and In plume stacked legs	13:19	13:53	0.2 – 13 kft, 11.5, 12, 13, 14 kft	Resample of high Depol ratio layer at around 5°S, 7°E. Not much evidence of dust from in situ. Multiple aerosol layers observed.
	<p>A wide-angle photograph showing a clear blue sky. Near the horizon, there is a distinct, thin layer of white, wispy clouds, likely a cirrus or cirrostratus layer, which appears to be at a lower altitude than the observer.</p>			
Transit back	13:59	14:19	20 kft	Clean, some precipitating clouds below from APR2 returns.

description	beginning time	end time	altitude	notes
				
landing	14:40:06	x	20 – 0 kft	Some convective cells starting near São Tomé. Few cirrus above, scattered Cumulus. Clean per respect to aerosol (AOD full column ~0.12). BC no more than 50 ng/m ³ .